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EXAMINER

KIELIN,E

ART UNIT

PAPER NUMBER

2813

DATE MAILED:

07/25/00

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.
09/388,826

Applicant(s)

Li et al.

Examiner

Erik Kielin

Group Art Unit

2813

☒ Responsive to communication(s) filed on Jun 8, 2000

☐ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire 3 month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) 1, 2, 4-14, 16-25, 34-42, and 44-51 is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1, 2, 4-14, 16-25, 34-42, and 44-51 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been
☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 5

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

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DETAILED ACTION

Claim Objections

1. Claim 1 is objected to because of the following informalities:

in line 5, replace "it" with -- said dielectric layer-- for clarity.

Appropriate correction is required.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless --

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

3. Claims 1, 2, 4-12, 14, 16-25, 34, 36, 37, 39-42, 44-51 rejected under 35 U.S.C. 102(e) as being anticipated by Yau et al. (US 6,054,379).

Yau discloses a method of forming low dielectric constant, interlayer dielectric comprising,

providing a substrate having integrated circuitry at least partially formed thereon (Figs. 6A-6E);

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forming an interlayer dielectric having a dielectric constant of about 3 or less (claim 5) and comprising $(\text{CH}_3)_x\text{SiO}_y$, using plasma enhanced CVD deposition technique with N_2O as an oxygen source in the plasma at a temperature less than 550 C, (column 3, lines 20-42; column 4, lines 8-16); and

after forming the dielectric layer, exposing it to a plasma comprising oxygen effective to reduce the dielectric constant (column 4, 10-11, and 14).

Note that because the dielectric is being deposited using a plasma comprising oxygen, the dielectric layer is necessarily exposed to the oxygen containing plasma **after** being deposited which would inherently result in a decrease in the dielectric constant of at least 15%, absent evidence to the contrary. See In re Best, 195 USPQ 428 (CCPA 1977) and In re Fitzgerald, 205 USPQ 594 (CCPA 1980).

Regarding claim 2, see Yau is silent to the stability of the dielectric, but this is inherent since both the instant invention and Yau expose to a plasma comprising oxygen.

Regarding claims 4-7 and 39-42, see Yau, column 4, lines 54-57. Also note, N_2O is the same as NO_x where $X = 1/2$.

Regarding claims 25 and 51, see Yau claim 39. Absent evidence to the contrary, the carbon cited in Yau is inherently in the form of methyl groups as methylsilane is the precursor to the dielectric layer, and the deposition methods are the same in Yau and the instant invention.

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Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1, 2, 4-14, 16-25, 34-42, 44-51 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yau et al. in view of Maeda et al. (US 5,800,877).

The prior art as explained above discloses all of the limitations of claims 1 and 34, but is silent to the period of time for exposure to the plasma comprising oxygen or whether the base chemistry changes upon exposure.

Maeda teaches a process called "reforming" in which a dielectric layer deposited by a CVD method using an alkylsilane as the source gas where the alkyl group can have one to three carbons (which means methyl is specifically included; column 6, lines 54-55) is treated, after deposition and within the same chamber, with a plasma containing oxygen or nitrogen, in order to remove excess moisture which "lower[s] the dielectric constant much more" (column 3, lines 1-10; column 5, line 45 to column 6, line 62).

It would have been obvious to one of ordinary skill in the art at the time the invention was made, to modify the method of Yau for the reasons taught by Maeda.

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Note that since moisture is removed, the base chemistry of the dielectric layer is explicitly not changed.

Note also in column 6, lines 22-32 that Maeda notes that better results are obtained for oxygen plasma than nitrogen plasma which may indicate that more is happening during the exposure than just moisture being removed.

Regarding claims 18-24, 46-50, although Maeda teaches 180 and 300 second exposures the choice of exposure time is a matter of routine optimization within the ordinary skill in the art. See In re Huang, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996) (claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art).

6. Claims 13 and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Yau et al. in view of Maeda et al. as applied to claims 1 and 34 above, and further in view of **Hochberg** et al. (US 4,992,306).

The prior art as explained above discloses all of the limitations of claims 1 and 34 but is silent to the use of nitrogen in the dielectric directly attached to the silicon atom with methyl groups also attached to the silicon atom.

Hochberg teaches a method of forming dielectric layers of silicon oxide and silicon oxynitride using alkylsilanes with a nitrogen containing function (whole document).

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It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Yau to form dielectric layers with nitrogen for all of the reasons taught in Mochberg.

7. Claims 1, 2, 4-7, 11, 12, 14, 16-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Brinker et al.** (US 5,948,482).

Brinker discloses a method of forming ultra-low dielectric constant, interlayer dielectric (column 1, lines 13-25) comprising,

providing a substrate having integrated circuitry at least partially formed thereon (column 1, lines 13-25);

forming an interlayer dielectric comprising R_xSiO_y where R is an alkyl group (which can be a methyl group (column 3, lines 20-42; column 4, lines 8-16); and

after forming the dielectric layer, exposing it to a plasma comprising oxygen effective to reduce the dielectric constant (column 5, lines 10-34-- especially lines 25-28; column 8, Table 1).

Brinker does not indicate that (1) the dielectric constant is less than 3.5 before the plasma treatment or (2) that the dielectric is reduced "by at least 15%." But these are inherent. Reasoning follows. Table 1 in column 8 indicates that the "As deposited film" is 40.20% porous (i.e. air containing) which means that the alkylsilane portion constitutes the remaining 59.8%. Because air has a dielectric of 1 and the alkylsilane cannot have a dielectric greater than 4 (that of pure silicon dioxide) the dielectric constant would be approximately a linear combination of the 0.4020 time 1

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plus 0.598 times 4 which equals 2.79. In short the as deposited dielectric constant would be at most about 2.79. Table 1 and column 5, lines 10-34 goes on to show that more porosity can be added by treatment with an oxygen plasma ultimately increasing the porosity to 89.37% which very clearly decreases the dielectric constant "by at least 15%."

Brinker does not indicate that the alkyl group is specifically a methyl group but clearly indicates that methyl is appropriate for the invention because methyl is the first in the series of alkyl groups. (See Hackh's Chemical Dictionary, page 27.)

Regarding claim 2, Brinker is silent to the stability of the dielectric, but this is inherent since both the instant invention and Brinker expose to a plasma comprising oxygen.

Regarding claims 5-7, Examiner gives official notice that the use of O_3 , N_2O , NO_x in plasma result in to formation of oxygen radicals and are art-known-equivalent oxygen sources for plasmas.

Regarding claims 18-24, Brinker is silent to the period of time for exposure to the plasma comprising oxygen, but indicates that the porosity and hence the dielectric can be tailored by the type of alkyl group and the quantity remaining (column 6, lines 20-34). It has been held that routine optimization is *prima facie* obvious, absent evidence of unexpected results. It would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize the exposure times in order to reduce the dielectric constant the desired amount. See In re Woodruff, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill

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of the art) and In re Aller, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

Regarding claim 25, Brinker is silent to the alkyl (hence methyl) group concentration, but the choice of 10% to 50% for the methyl group concentration is obvious for the reasons just stated.

Double Patenting

8. Applicant is advised that should claim 1 be found allowable, claim 17 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

9. Claims 1, 2, 4-14, 16-25, 34-42, 44-51 provisionally rejected under the judicially created doctrine of double patenting over claims 1-9, and 11 of copending Application No. 09/146,397, and alternatively over claims 46-48, and 50 of copending application 09/200,035. This is a provisional double patenting rejection since the conflicting claims have not yet been patented.

The subject matter claimed in the instant application is fully disclosed in the referenced copending application and would be covered by any patent granted on that copending application since the referenced copending application and the instant application are claiming common

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subject matter, as follows: Formation of an interlayer dielectric with a dielectric constant less than 3.5 containing carbon and then treating with an oxygen plasma which inherently results in a decrease in the dielectric constant of said dielectric layer.

Furthermore, there is no apparent reason why applicant would be prevented from presenting claims corresponding to those of the instant application in the other copending application. See *In re Schneller*, 397 F.2d 350, 158 USPQ 210 (CCPA 1968). See also MPEP § 804.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

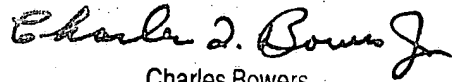
Harada (US 5,260,600) teaches that addition of oxygen or ozone to a plasma in the deposition of a silicon oxynitride film reduces the dielectric constant thereof (column 9, lines 25-33).

Any inquiry concerning this communication from examiner should be directed to Erik Kielin whose telephone number is (703) 306-5980. The examiner can normally be reached by telephone on Monday through Thursday 9:00 AM until 7:30 PM.

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Bowers, can be reached on (703) 308-2417. The fax phone number for the group is (703) 308-7722 or -7724.

EK



Charles Bowers

Supervisory Patent Examiner
Technology Center 2800

July 22, 2000